WHAT IS CLAIMED IS:

1. A magnetic memory device comprising:

a substrate; and

a wiring layer formed on the substrate,

wherein the wiring layer includes a lower electrode, a magneto-resistive element formed on the lower electrode and configured to include an insulation barrier layer, at least one contact layer stacked on the magneto-resistive element, and an upper wiring connected to the contact layer, and a taper angle of a side surface of the magneto-resistive element including the insulation barrier layer, relative to a bottom surface of the magneto-resistive element, is about 60° or less.

2. The magnetic memory device according to claim 1, wherein the contact layer and the magneto-resistive element are formed in a self-alignment manner.

3. The magnetic memory device according to claim 1, further comprising a mask formed adjacent to the magneto-resistive element on the lower electrode.

4. The magnetic memory device according to claim 1, wherein the contact layer has a greater taper angle than the taper angle of the magneto-resistive element.

5. The magnetic memory device according to claim 1, wherein the magneto-resistive element includes

an insulation barrier layer and at least two magnetic layers formed on both sides of the insulation barrier layer, the insulation barrier layer and the at least two magnetic layers having substantially equal etching rates with respect to an ion beam used for etching.

6. The magnetic memory device according to claim 1, wherein a junction resistance per unit area of the magneto-resistive element is $10^6 \Omega \cdot \mu m^2$.

7. A method of manufacturing a magnetic memory device, comprising:

forming an insulation layer on a substrate;

forming a lower electrode on the insulation layer;

forming a magneto-resistive film on an upper surface of the lower electrode, the magneto-resistive film including an insulation barrier layer and a plurality of magnetic films stacked on both sides of the insulation barrier layer;

stacking a mask layer on the magneto-resistive film; and

performing ion etching on the magneto-resistive film, using the mask layer as a mask, thereby forming a magneto-resistive element, such that a center of distribution of sputter substance dispersed by an ion beam is located away from a side surface of the magneto-resistive element.

8. The method of manufacturing a magnetic memory device, according to claim 7, wherein at the time of

the ion etching, a taper is formed on the side surface of the magneto-resistive element such that an angle of the side surface of the magneto-resistive element to a bottom surface of the magneto-resistive element is about 60° or less.

9. The method of manufacturing a magnetic memory device, according to claim 7, wherein an incidence angle θ of the ion beam is set to satisfy the equation,

$$\theta = \theta t - \theta m$$

where θm is the ion beam incidence angle at which a maximum sputtering efficiency of the mask is obtained,

θt is the taper angle of a side surface of the mask, and

θ is the incidence angle of the ion beam to a normal line of the substrate.

10. The method of manufacturing a magnetic memory device, according to claim 8, wherein an incidence angle θ of the ion beam is set to satisfy the equation,

$$\theta = \theta t - \theta m$$

where θm is the ion beam incidence angle at which a maximum sputtering efficiency of the mask is obtained,

θt is the taper angle of a side surface of the mask, and

θ is the incidence angle of the ion beam to a normal line of the substrate.

11. The method of manufacturing a magnetic memory device, according to claim 7, wherein the magneto-resistive element is formed in a self-alignment manner, relative to the mask.

12. The method of manufacturing a magnetic memory device, according to claim 7, further comprising a cleaning step of cleaning the side surface of the magneto-resistive element, after forming the magneto-resistive element by performing the ion etching on the magneto-resistive film.

13. The method of manufacturing a magnetic memory device, according to claim 12, wherein the cleaning step includes a step of applying an ion beam to the side surface of the magneto-resistive element.

14. The method of manufacturing a magnetic memory device, according to claim 7, wherein the ion etching uses argon ions.

15. The method of manufacturing a magnetic memory device, according to claim 7, wherein the ion etching is effected by RIE.

16. The method of manufacturing a magnetic memory device, according to claim 7, wherein a positional relationship between an ion source for the ion etching and the substrate is varied such that all side surfaces of the magneto-resistive element are directed to the ion source.

17. A magnetic memory device comprising:

a substrate; and

a wiring layer formed on the substrate,

wherein the wiring layer includes a lower electrode, a magneto-resistive element formed on the lower electrode and configured to include an insulation barrier layer, at least one contact layer stacked on the magneto-resistive element, and an upper wiring connected to the contact layer, and

the magneto-resistive element has an inclined side surface which is cleaned by ion beam etching after the magneto-resistive element is formed by ion beam etching.

18. The magnetic memory device according to claim 17, wherein the cleaned inclined side surface is an exposed surface obtained by etching away an insulation film which is provided to cover an entirety of the magneto-resistive element after the magneto-resistive element is formed by the ion beam etching.

19. A magnetic memory device comprising:

a substrate; and

a wiring layer formed on the substrate,

wherein the wiring layer includes a lower electrode, a magneto-resistive element formed on the lower electrode and configured to include an insulation barrier layer, at least one contact layer stacked on the magneto-resistive element, and an upper wiring connected to the contact layer, and

an insulation film, which is provided to cover an entirety of the magneto-resistive element after the magneto-resistive element is formed by ion beam etching, is formed of a material that is more easily oxidizable than the lower electrode.

20. The magnetic memory device according to claim 19, wherein the magneto-resistive element has an inclined side surface which is cleaned by ion beam etching after the magneto-resistive element is formed by ion beam etching,

the cleaned inclined side surface is an exposed surface obtained by etching away an insulation film which is provided to cover an entirety of the magneto-resistive element after the magneto-resistive element is formed by the ion beam etching, and

a recess is formed due to over-etching by the ion beam when the magneto-resistive element is formed by the ion beam etching.

21. The magnetic memory device according to claim 17, wherein the magneto-resistive element includes an insulation barrier layer and at least two magnetic layers formed on both sides of the insulation barrier layer, the insulation barrier layer and the at least two magnetic layers having substantially equal etching rates with respect to an ion beam used for etching.

22. The magnetic memory device according to

claim 19, wherein the magneto-resistive element includes an insulation barrier layer and at least two magnetic layers formed on both sides of the insulation barrier layer, the insulation barrier layer and the at least two magnetic layers having substantially equal etching rates with respect to an ion beam used for etching.

23. A method of manufacturing a magnetic memory device, comprising:

forming an insulation layer on a substrate;

forming a lower electrode on the insulation layer;

forming a magneto-resistive film on an upper surface of the lower electrode, the magneto-resistive film including an insulation barrier layer and a plurality of magnetic films stacked on both sides of the insulation barrier layer;

stacking a mask layer on the magneto-resistive film;

performing ion etching on the magneto-resistive film, using the mask layer as a mask, thereby forming a magneto-resistive element;

forming an insulation film on upper surfaces of the mask, the magneto-resistive element and the lower electrode; and

etching the insulation film with an ion beam such that a side surface of the magneto-resistive element is exposed.

24. A method of manufacturing a magnetic memory device, comprising:

forming an insulation layer on a substrate;

forming a lower electrode on the insulation layer;

forming a magneto-resistive film on an upper surface of the lower electrode, the magneto-resistive film including an insulation barrier layer and a plurality of magnetic films stacked on both sides of the insulation barrier layer;

stacking a mask layer on the magneto-resistive film;

performing ion etching on the magneto-resistive film, using the mask layer as a mask, thereby forming a magneto-resistive element, and also over-etching an upper part of the lower electrode, thereby forming a recess at the upper part of the lower electrode;

forming an insulation film on upper surfaces of the mask, the magneto-resistive element and the lower electrode including the recess; and

etching the insulation film with an ion beam such that a side surface of the magneto-resistive element is exposed and the insulation film remains on the lower electrode.

25. The method of manufacturing a magnetic memory device, according to claim 24, wherein the insulation film is formed of a material that is more easily oxidizable than the lower electrode.

26. The method of manufacturing a magnetic memory device, according to claim 24, wherein the insulation film is formed of an oxygen-free material.

27. The method of manufacturing a magnetic memory device, according to claim 23, wherein when the magneto-resistive element is formed, an etched substance, which is dispersed and attached at the time of the ion beam etching, is removed from the side surface of the magneto-resistive element by the ion beam.

28. The method of manufacturing a magnetic memory device, according to claim 24, wherein when the magneto-resistive element is formed, an etched substance, which is dispersed and attached at the time of the ion beam etching, is removed from the side surface of the magneto-resistive element by the ion beam.

29. The method of manufacturing a magnetic memory device, according to claim 23, wherein the following equation is satisfied:

$$t = d*(ER(\theta mtj - \theta) - ER(\theta)) / (ER(\theta mtj - \theta)*ER(\theta))$$

where θmtj is a taper angle of the side surface of the magneto-resistive element,

$ER(\theta mtj)$ is an etching rate of the magneto-resistive element as a function of θmtj,

$ER(\theta)$ is an etching rate of the insulation film

formed on the magneto-resistive element as a function of an incidence angle θ of an ion beam at the time of etching,

d is the thickness of the insulation film, and

t is a time at which only the side surface of the magneto-resistive element is exposed by the ion etching.

30. The method of manufacturing a magnetic memory device, according to claim 24, wherein the following equation is satisfied:

$$t = d*(ER(\theta mtj - \theta) - ER(\theta)) / (ER(\theta mtj - \theta)*ER(\theta))$$

where θmtj is a taper angle of the side surface of the magneto-resistive element,

$ER(\theta mtj)$ is an etching rate of the magneto-resistive element as a function of θmtj,

$ER(\theta)$ is an etching rate of the insulation film formed on the magneto-resistive element as a function of an incidence angle θ of an ion beam at the time of etching,

d is the thickness of the insulation film, and

t is a time at which only the side surface of the magneto-resistive element is exposed by the ion etching.